# A QUANTITATIVE ESTIMATE OF BARN OWL NESTING HABITAT QUALITY

By

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Scope and Method of Study: The purpose of this study was to demonstrate that habitat variables can be used to estimate the quality of wildlife habitat. The specific objective was to develop a model to estimate the quality of barn owl nesting habitat. Five years reproductive data on 11 barn owl nest sites were used as the dependent variable to develop a regression model to estimate nesting habitat quality. The independent variables for the regressions were; habitat variables (e.g. ha of wheat, km of edge), rodent abundance, owl pellet contents, and areas of owl use.

Findings and Conclusions: The habitat variables of kilometers of road, habitat diversity, and hectares of grain were significantly related ($R^2 = 0.90$) to mean reproductive success and therefore assumed to be good indicators of nesting habitat quality. Pellet contents were also related to mean reproductive success ($R^2 = 0.96$) but this relationship is believed to function through habitat. No relationship was found between abundance of rodents within a 1-km radius of nest sites, and mean reproductive success ($r^2 = 0.11$). The results support the hypotheses that birds select sites visually by gross structural features of the habitat (proximate factor), and that sites vary in their ability to support breeding birds. Similar work with other species should provide the data required to accurately and objectively estimate habitat quality based on the measurement of continuous habitat variables.


ADVISER'S APPROVAL John A. Bissonette

A QUANTITATIVE ESTIMATE OF BARN OWL

NESTING HABITAT QUALITY

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# PREFACE

The purpose of this study was to determine if habitat variables can be used to objectively estimate the quality of wildlife habitat. The specific objective was to develop a regression model, based on habitat variables, that objectively estimates the quality of barn owl nesting habitat.

Financial support for the study was provided by the Oklahoma Cooperative Wildlife Research Unit, Oklahoma Ornithological Society, Scholarships Foundation, Inc., and Sigma XI. Housing used during the course of the study was provided by the Oklahoma Cooperative Wildlife Research Unit, Leon and Eula Williams, and Rick and Bonnie Leppla.

I appreciate the support and encouragement I received from my major adviser, Dr. John A. Bissonette, past Assistant Leader, Oklahoma Cooperative Wildlife Research Unit. I thank Dr. O. Eugene Maughan, Leader, Oklahoma Cooperative Fisheries Research Unit, and Dr. William Warde, Associate Professor, Department of Statistics, for serving as members of my graduate committee.

Many landowners allowed me access to their property and I thank them: James Avant, Billy Brewer, Eldes Huckabay, Bill Hulett, Bud Leverett, Carl Richeson, Lyle Tigert, and O. E. Weddle. The people of Eldorado, Oklahoma were always kind and my time spent there was enjoyable.

I thank Vicki Clark, Kurt Cunningham, and Don Martin for their valuable assistance in the field. And lastly, I thank Jim Tinsley for his years of friendship and for introducing me to barn owls nesting in cisterns.

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CHAPTER I

# INTRODUCTION

The format and style of Chapter II of this thesis meets the manuscript specifications for a scientific journal. Deviation from the standard format was used to expedite submission of the thesis to THE JOURNAL OF WILDLIFE MANAGEMENT and is complete without additional data.

Written approval for submitting the thesis in this format was received from the Dean of the Graduate College, on July 8, 1981, in accordance with standard policy.

CHAPTER II

# A QUANTITATIVE ESTIMATE OF BARN OWL NESTING HABITAT QUALITY

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Abstract: Data on 5 years reproductive success at 11 barn owl (*Tyto alba*) nest sites were used as the dependent variable in a regression model estimating nesting habitat quality. The habitat variables of kilometers of road, habitat diversity, and hectares of grain (independent variables) were significantly related ($R^2 = 0.90$) to mean reproductive success and therefore assumed to be good indicators of nesting habitat quality. Although pellet contents were also related to reproductive success ($R^2 = 0.96$) this relationship is believed to function through habitat. No relationship was found between abundance of rodents within a 1-km radius of nest sites and mean reproductive success ($r^2 = 0.11$). The results support the hypotheses that birds select sites visually by gross structural features of the habitat (proximate factor), and that sites vary in their ability to support breeding birds. Similar work with other species should provide the

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data required to accurately and objectively estimate habitat quality based on the measurement of continuous habitat variables.

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More than 40 years ago Aldo Leopold (1937) commented on the problem and need for wildlife habitat assessment (quantification). Today, although the need still exists (Balda 1975, Schamberger and Farmer 1978, Shugart et al. 1978, Stauffe and Best 1980, USFWS 1980), wildlife biologists lack a commonly accepted procedure by which to quantify habitat (Williams et al. 1977). Community and species approaches are currently being used in attempts to rectify this deficiency. The community approach uses multivariate techniques to relate habitat variables or plant communities to species diversity, or to separate habitat requirements of several species (James 1971, Anderson and Shugart 1974, Shugart et al. 1975, Whitmore 1977, Anderson 1979, Crawford et al. 1981). This approach quantifies habitat in the sense of habitat identification and/or separation, not quality of habitat at different levels of habitat variables (Daniel and Lamaire 1974, Williams et al. 1977, USFWS 1980). Identification of habitat quality is the objective of some species approaches. Quality may be able to be estimated by relating continuous habitat variables, in specific habitat types, to number of animals (Lennartz and Bjugstad 1975, Shugart et al. 1978, Niemi and Pfannmuller 1979, USFWS 1980).

Associations between habitat and vertebrate parameters have been studied by several biologists (e.g. Conner and Adkisson 1976, Hebrard 1978, Greenwood and Hubbard 1979, Wray and Whitmore 1979, Weller 1979, O'Meara et al. 1981, Whitmore 1981) and in many instances significant relationships were found to exist between habitat and population parameters. Reproductive success (Krebs 1971, Holm 1973, Greenwood and Hubbard 1979), survival (Fox 1978) and dominance (Fox et al. 1981) were found to increase in high quality habitat, while nest spacing decreased (Newton and Marquiss 1976). Results of these and other studies support the hypotheses that territories vary in their capacity to support successful breeding (Newton and Marquiss 1976) and/or that habitat selection is based on gross visual aspects of the habitat (Hilden 1965).

Habitat quantification studies have generally identified only the range of habitat variables in which a species is found. Few attempts have been made to estimate habitat quality (e.g. Meents et al. 1981), for a given species, through measurement of habitat variables. The initial objective of this study was to determine relationships between mean reproductive success and selected habitat variables, rodent abundance, owl pellet contents, and areas of owl use. The ultimate objective was to develop a model to estimate quality of barn owl nesting habitat based on the regression of mean reproductive success on habitat variables. Judgements regarding which variables to measure and/or include in the model were based in our opinion of more useful vs. less useful (Caswell et al. 1972). Because we wanted a model based on habitat characteristics, habitat variables were deemed "more useful". This course of action was suggested because of general agreement that birds select sites based on gross visual aspects of the habitat, which is a proximal factor of site selection (Hilden 1965) and an indicator of ultimate factors (Shugart and Patten 1972). Our basic assumptions were that mean reproductive success is positively correlated with higher quality sites, and a model which estimates mean reproductive success will also estimate nesting habitat quality.

We gratefully acknowledge the financial support provided by the Oklahoma Cooperative Wildlife Research Unit (OCWRU), Oklahoma Ornithological Society, Scholarships Foundation, Inc., and Sigma XI. Logistical support was received from the OCWRU, Leon and Eula Williams, and Rick and Bonnie Leppla. Valuable field assistance was provided by V. Clark, K. Cunningham, and D. Martin.

STUDY AREA

The study was conducted from 1977-1981 near Eldorado, Oklahoma (Fig. 1) at the northern limit of the Mesquite-Buffalograss ecoregion. Barn owls were common on the study area and nested in cisterns, barns, sheds, abandoned houses, and holes in banks. Cisterns are concrete lined "wells", 10-20 ft deep, built in the early 1900's for water storage. The cisterns are now usually dry.

Native vegetation on the study area was predominately common mesquite (Prosopis juliflora) less than 5 m tall with a ground cover of grasses and scattered shrubs (Bailey 1978). The most abundant grasses were common buffalograss (Buchloe dactyloides) and gramma grasses (Bouteloua spp.). Common shrub species were lotewood condalia (Condalia obtusifolia), fragrant sumac (Rhus aromatica), and small soapweed (Yucca glauca). Cacti (Opuntia spp.) were fairly common. The major agricultural crops on the study area were wheat and sorghum. These grains were planted in 32-259 ha units and resulted in an irregular patchwork of cropland and mesquite. Cattle were grazed on wheat during late fall and winter, and on mesquite "pasture" during the remainder of the year.

# METHODS

## Habitat Variables

Habitat variables were measured from aerial photographs (1:7920, December 1978), using a Numonics Model 1224 digitizer. Area (ha) of wheat, mesquite, sorghum, and herbland; and kilometers of road and edge (without road included) were determined within a 1-km radius of 11 barn owl nest sites. Roadside vegetation was subjectively divided into 2 categories and measured in kilometers. Dense roadside had a vegetative canopy cover $>$ 50%, sparse roadside had $<$ 50%. Habitat diversity was obtained by counting the number of discrete units of each cover type within a 1-km radius of each nest site and then summing the number of units of each type across all cover types. The variable of grain was created by summing the areas of wheat and sorghum.

## Reproductive Success

Reproductive success, the number of young fledged/year, was recorded for 11 nest sites (9 cisterns, 2 barns) for each year from 1977-1981. The number of nestlings present was recorded at weekly intervals and the number present at the last check before the birds fledged was assumed to be the number fledged. When human-induced abandonment occurred no value was recorded.

## Small Mammal Trapping

Small mammals were trapped in 4 cover types (wheat, mesquite, sorghum, and herbland) from June-August 1980 and in 6 cover types (wheat, mesquite, sorghum, herbland, sparsely vegetated roadside, and densely vegetated roadside) from May-July 1981. Four repetitions were run in each cover type each year. A partially balanced incomplete block design was used to determine the order in which the cover types were sampled. A line of 25 Sherman live traps, baited with a peanut butter-oatmeal mixture and spaced 15 m apart, was placed in each of 2 cover types per night. The lines were checked each morning and data on species captured, cover type, date, weight, and repetition number were recorded on data sheets. Captured animals were marked by toe clipping to allow identification of recaptures and released. The data from the 2 years were summed because the purpose of the trapping was to estimate relative abundance (abundance ≠ availability) of rodents by cover type; not to determine temporal variations within cover types.

Pellet Analyses

Pellets and pellet fragments were collected from all active nest sites during the summers of 1980 and 1981. Each pellet was dissected, and collection location, date, number of prey items, and number of species were recorded on data sheets. Results for pellet fragments were lumped by sites. Mammalian remains were identified by using a reference collection and skull key (Glass 1973). To avoid possible double counting, only unduplicated skull parts were used for identification and tallying (Marti 1969). Percent live biomass (estimated avg. live wt.) and frequency of occurrence (%) of each prey species was calculated from pellets from each nest site.

Areas of Owl Use

Radio-transmitters were attached to nesting adult barn owls during the 1980 and 1981 breeding seasons. Birds nesting in cisterns were captured by hand and fitted with a 30-g transmitter. A receiver and hand-held antenna were used to triangulate locations of radio-equipped birds. Locations were determined during all hours of darkness, from July-August 1980 and May-August 1981. Data on date, time, bearing, and point from which the bearing was taken were recorded on field forms. Locations were later plotted on cover maps.

Analyses

Single and multiple linear regression techniques were used to determine the relationships among habitat variables (independent variables) and mean reproductive success (dependent variable) in order to develop a model to estimate habitat quality. A test of the model was conducted using data from 2 nest sites in barns (10,11) which were not included in the development of the model, but for which reproductive data were known. The values for road, diversity, and grain were determined from aerial photographs and inserted into the fitted regression equation. Analysis of Variance (ANOVA) was used to identify differences in mean reproductive success among nest sites and rodent biomass among cover types. Chi-square analyses were used to determine if habitat was used in proportion to its availability. Differences in habitat variables and pellet contents among sites were determined by inspection. The Observed Significance Level (OSL) for all statistical tests are given in the results section.

RESULTS

Habitat Variables

Habitat variables within a 1-km radius of the nest sites differed greatly (Table 1). Hectares of the 2 dominant cover types, wheat and mesquite, ranged from 44.09–282.08 ha and 6.90–238.13 ha respectively. Sorghum and herbland were usually only a small proportion of the area. Kilometers of road within the circle ranged from 1.029–4.098 km, kilometers of edge from 4.73–20.89, and habitat diversity from 16–57.

Reproductive Success 

The number of barn owls fledged was significantly different among nest sites (ANOVA, $\underline{P}$ = 0.0014, df = 10,33) and years ($\underline{P}$ = 0.0183, df = 4,33) (Table 2). As expected the frequency of a site being used was positively correlated with mean reproductive success ($\underline{r}^2$ = 0.73). The mean number of young fledged per attempt, over the 5 year period was 2.81, 3.44 young were fledged per successful attempt. Six of 38 attempts were unsuccessful. Eggs were present at all sites during at least 2 of the 5 years of the study, indicating the sites were at least marginally acceptable to barn owls.

Small Mammal Trapping

One hundred ten individuals of 6 genera were captured in 3000 trap-nights (1980,1981). Pocket mice (*Perognathus* spp.) were captured in the greatest number (31). Other species trapped were: deer mice (*Peromyscus* spp.) (24), hispid cotton rats (*Sigmodon hispidus*) (22), southern plains woodrats (*Neotoma micropus*) (19), harvest mice (*Reithrodontomys* spp.) (11), and northern grasshopper mice (*Onychomys leucogaster*) (3).

The mean biomass of rodents captured was significantly different among cover types (ANOVA, $\underline{F}$ = 3.97, $\underline{P}$ < 0.0001) (Table 3). Sorghum fields and densely vegetated roadsides yielded the greatest mean biomass per repetition, 522.6 g and 454.8 g respectively. These cover types had the greatest canopy cover and density of herbaceous stems. Rodent biomass in herbland and mesquite was intermediate (184.6 g and 136.8 g). Wheat fields and roadside with sparse vegetation yielded the lowest biomass (18.3 g and 14.3 g). These 2 cover types provide essentially no cover for rodents. The wheat fields were harvested in early June (early nestling period for barn owls) and immediately plowed, removing all herbaceous vegetation.

Pellet Contents

Two hundred twenty-five pellets and pellet fragments containing a total of 680 skulls were collected from 9 nest sites (8 active, 1 inactive) during 1980 and 1981. The percent of live biomass of prey species was determined for each cistern from pellets and fragments (Table 4). The frequency of occurrence (%) of prey species was determined using only complete pellets (Table 5). Grasshoppers (Acrididae), bullsnakes, bobwhite and scaled quail (Colinus virginianus, Callipepla squamata), and cottontailed rabbits (Sylvilagus spp.) occurred in such low numbers they were not included in the analyses.

Pocket mouse was the most important prey species in terms of biomass and frequency of occurrence. Its percent biomass ranged from 18-40% with a mean of 29% for all sites. Frequency of occurrence ranged from 28-100% with a mean of 46%. Although cotton rat skulls were found in only 15% (range 0-36%) of the pellets they made up 24% (6-67%) of the total biomass, and was the second most important species in terms of biomass. Woodrat skulls occurred in 7% (0-21%) of the pellets, but ranked third in terms of biomass with 20% (0-41%). The biomass of the other 6 species each averaged less than 10% (tr-9%), however, the frequency of occurrence of harvest mouse averaged 28% (0-44%) and deer mouse 27% (0-55%).

Areas of Owl Use

Twelve barn owls were captured and fitted with transmitters during the 1980 and 1981 breeding seasons. Data from 8 birds (3 in 1980, 5 in 1981) on which 365 locations were obtained, were used in the analyses. No locations were taken on 4 birds due to transmitter failure or nest-abandonment.

Forty-five point eight percent (range from 22.2-81.3% for individual birds) (Table 6) of locations where the birds were observed were within the 1-km radius circle. Males were encountered more often within the 1-km circle, 58.1 vs 38.4%, but the difference was not statistically significant ($\underline{t}$ = 0.2846, $\underline{P} > 0.25$).

Use of cover types (Table 7) was not proportioned to the occurrence of each type within the study area ($\underline{X}^2 = 17.5$, $\underline{P} < 0.005$). More use than expected was recorded in wheat, herbland, and sorghum fields. Wheat comprised 41.6% of the study area but contained 54.2% of the locations where birds were triangulated. Herbland composed 7.0% of the area but 12.5% of the locations and sorghum with 2.3% of the area had 4.2% of the locations. Mesquite was used less than expected; having 49.0% of the area it contained only 29.2% of the locations.

Model Development

The ultimate goal of this study was to develop a habitat variable model to estimate nesting habitat quality (inferred through reproductive success). Prerequisite to the development of a predictive regression model are differences in the dependent and independent variables. As shown, differences exist among sites in the measured parameters (Tables 1, 3-7) and mean reproductive success (Table 2).

The model we developed, $\hat{Y} = -1.384 + 1.173X_1 + 0.026X_2 - 0.005X_3$ ($\underline{R}^2 = 0.90$, $\underline{P} = 0.0045$), estimates mean reproductive success based on the habitat variables of kilometers of road ($X_1$), habitat diversity ($X_2$), and hectares of grain ($X_3$). Only data from the 9 cisterns (sites 1-9) were used to develop this equation. The test of the model predicted mean reproductive success for site 10 at 3.27, the observed value was 3.5. The predicted value of mean reproductive success for site 11 was 2.96, and the observed value was 2.6. Because the estimated values were close to the observed values we combined the data from barns and cisterns and developed a new model, $\hat{Y} = -1.407 + 1.162X_1 + 0.026X_2 - 0.004X_3$ ($\underline{R}^2 = 0.90$, $\underline{P} = 0.0008$), which included the same habitat variables.

When all types of edge were used to estimate mean reproductive success the resulting $\underline{r}^2$ value was 0.49. When road alone was used the $\underline{r}^2$ was 0.82, the confidence interval narrower, and the slope steeper.

Differences in rodent abundance between years have been suggested as being related to variations in reproductive success of barn owls (Otteni et al. 1972). To test this hypothesis simple linear regression was used to determine the relationship between rodent biomass within a 1-km radius of nest sites and mean reproductive success. The resulting $\underline{r}^2$ of 0.11 ($\underline{P} = 0.43$) indicates that rodent biomass is a poor estimator of mean reproductive success.

Relationships between frequency of occurrence (%) and biomass of prey species in pellets were examined. The best relationship between biomass of prey in pellets and reproductive success was with cotton rats ($\underline{r}^2 = 0.18$, $\underline{P} = 0.30$) and was judged to be inadequate. However the frequency of occurrence of cotton rat, woodrat, and deer mouse skulls in pellets were significantly related to mean reproductive success ($\underline{R}^2 = 0.96$, $\underline{P} = 0.0002$). These results seem to suggest that mean reproductive success might be estimated by the frequency of occurrence of species in pellets. However, the frequency of occurrence of the pocket mouse was also related to the habitat components of road and mesquite ($R^2$ = 0.72, $P$ = 0.04), cotton rat to road, grain, and diversity ($R^2$ = 0.75, $P$ = 0.10), and woodrat to mesquite ($r^2$ = 0.78, $P$ = 0.003). These are the same habitat variables, except for mesquite, that were related to mean reproductive success. Therefore, frequency of occurrence of prey items in pellets is related to mean reproductive success indirectly through relationships with habitat variables.

No relationship ($r^2$ = 0.002) was found between the percent of radio locations within a 1-km radius of the nest sites and mean reproductive success.

## DISCUSSION

If our assumptions were correct the nest site quality model will predict mean reproductive success and estimate nesting habitat quality. The habitat components of kilometers of road, habitat diversity, and hectares of grain, as well as the frequency of use of a site, were all related to mean reproductive success ($R^2$ = 0.90, $r^2$ = 0.73). This relationship implies that sites with the best mix of these characteristics were used more often for nesting, and therefore had higher mean reproductive success.

Kilometers of road was the single most important element in the regression equation and accounted for 82% of the variation in mean reproductive success among sites. The biological significance of this measure is that "road" actually measures the habitat complex associated with road (roadside vegetation, fence posts, and road) and is in reality a measure of a specific type of edge. The herbaceous vegetation growing on the roadside supplies prime habitat for many rodents and especially cotton rats (Goertz 1964). Fence posts, which parallel the roads, provide perch sites immediately above this potential source of prey. The bare road surface could increase the vulnerability of rodents to predation. We speculate that given the presence of nest sites, barn owls in our study area visually selected a nest site based primarily on the amount of road (proximate factor) within the area.

Increased edge is often reported to be beneficial to many species and associated with increased species diversity. Our results show that the amount of edge (e.g. road) was related to mean reproductive success of barn owls, and that types of edge vary in their ability to predict mean reproductive success (Fig. 2). This relationship infers that edge varies in its' ability to support wildlife populations.

Variation in mean reproductive success among sites was also affected by elements other than habitat (Fig. 3) but control seemed to involve certain aspects of habitat quality. Weather no doubt influenced annual reproductive success of the owl population through its' effect on the rodent population. However the effect of weather was similar at all sites in a given year, and therefore did not affect site to site variation in mean reproductive success. Random factors of human disturbance, flooding, predation, and the death of a parent also effected reproductive success on an annual basis, but did not have a great effect of the mean number of owls fledged.

Abundance of prey has been related to yearly variation in the number of barn owls fledged (Otteni et al. 1972). Although we found differences in rodent abundance among cover types and within a 1-km radius of nest sites these differences were at best indirectly related to mean reproductive success. For example, although the frequency of occurrence of cotton rat, woodrat, and deer mouse, in pellets was associated ($\underline{R}^2$ = 0.96, $\underline{P}$ = 0.002) with mean number of owls fledged, the frequency of occurrence of cotton rat skulls in pellets was also related ($\underline{R}^2$ = 0.75, $\underline{P}$ = 0.10) to road, diversity, and grain. The same variables that are in the fitted regression equation.

The quality (e.g. experience) of a bird may affect annual reproductive success, however our data do not show it controls mean reproductive success. Although the best bird may get the best site the quality of a bird and a site are probably not independent (Newton 1979:135). We used mean reproductive success which lessened the effect of individual birds on the data and allowed us to isolate habitat effects. The effect of the quality of individual birds was further reduced by the facts that not all nest sites are used in a given year (Table 2), the average life span of owls in the study area is 2½ years (Stewart 1952), and that some birds change sites from year to year (Table 8). These factors in concert seem to indicate that barn owl densities are not at carrying capacity for nesting sites.

Regardless of the effects of the factors discussed, the relationship between habitat variables and mean reproductive success is real and has predictive capability. For example, the model closely estimated mean reproductive success for sites 10 and 11 and correctly predicted higher reproductive success for site 10 (3.27) than for site 11 (2.96).

The development of the model to predict mean reproductive success was relatively simple and accurate with respect to data collection and analyses. Measurement of habitat parameters (independent variables) from aerial photographs was both easy and accurate, whether for large or small areas. The count of nestlings (dependent variable) was accurate and did not have the many biases associated with census techniques. After the model was developed it was not necessary for the animal to be present for the technique to be used.

We believe that similar work should be attempted to quantify the quality of habitat for other species. Data should be collected on continuous habitat variables during all seasons of the year and related to some measure of the species abundance. With additional data on several "indicator" species it may then be possible to provide the information needed by the several habitat quantification procedures to objectively determine the quality of wildlife habitat.

## CONCLUSIONS

Estimation of nesting habitat quality through the regression of habitat variables on mean reproductive success appears sound. The data also support the biological hypotheses that habitat varies in quality and that sites are selected on the basis of gross visual aspects of the habitat. The differences in habitat quality provides the basis to use regression analyses to identify relationships between mean reproductive success and habitat variables, and thereby objectively estimate habitat quality.

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Table 1. Cover type (ha) and habitat component variables (km, N) within 1-km radius of 11 barn owl nest sites in southwestern Oklahoma (1977-1981).

| | COVER TYPES | | | | | HABITAT COMPONENTS | | |
|---|---|---|---|---|---|---|---|---|
| NEST SITE | HA WHEAT | HA MESQUITE | HA SORGHUM | HA HERB. | HA GRAIN | KM ROAD | HABITAT DIVERSITY (N) | KM EDGE WO/ROAD |
| 1 | 186.57 | 45.60 | 3.68 | 72.54 | 190.25 | 3.997 | 57 | 20.89 |
| 2 | 158.78 | 119.77 | 18.90 | 12.93 | 177.68 | 3.786 | 36 | 17.89 |
| 3 | 166.15 | 71.39 | 4.25 | 60.20 | 170.40 | 3.954 | 32 | 16.41 |
| 4 | 68.62 | 238.13 | 3.60 | 0.00 | 72.22 | 1.999 | 16 | 11.42 |
| 5 | 149.86 | 152.65 | 0.00 | 1.38 | 149.86 | 2.899 | 27 | 16.19 |
| 6 | 44.09 | 239.16 | 20.29 | 0.00 | 64.38 | 3.635 | 19 | 9.14 |
| 7 | 121.07 | 187.60 | 0.00 | 4.57 | 121.07 | 2.002 | 17 | 13.61 |
| 8 | 282.08 | 12.69 | 0.00 | 12.36 | 282.08 | 3.971 | 15 | 4.73 |
| 9 | 74.61 | 272.04 | 0.45 | 0.00 | 75.06 | 1.029 | 18 | 7.83 |
| 10 | 113.68 | 6.90 | 0.00 | 183.30 | 113.68 | 4.098 | 16 | 11.39 |
| 11 | 101.50 | 187.17 | 0.00 | 8.37 | 101.50 | 3.716 | 19 | 17.76 |

Table 2. Number of barn owls fledged at 11 nest sites in southwestern Oklahoma, 1977-1981.

| YEAR | NEST SITE 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | AVG. NUMBER FLEDGED PER ATTEMPT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1977 | 0[a] | 2 | –[b] | 0[a] | 3 | –[b] | 0 | 4 | 0 | 3 | 3 | 2.14 |
| 1978 | 4 | 3 | –[b] | 0 | 0[c] | 2 | 0 | 2 | 0 | 4 | 3 | 1.80 |
| 1979 | 4 | 5 | 4 | 4 | 4 | 5 | 1 | 0[a] | 0[a] | 5 | 5 | 4.11 |
| 1980 | 5 | 4 | 4 | –[b] | 4 | 4 | 0[a] | 3 | 0[a] | –[b] | 2 | 3.71 |
| 1981 | 4 | 1[d] | 4 | –[b] | 3 | 0[a] | 0[a] | –[b] | 0[a] | 2 | 0 | 2.33 |
| $\bar{x}$ | 3.40 | 3.00 | 4.00 | 1.33 | 2.80 | 2.75 | 0.20 | 2.25 | 0.00 | 3.50 | 2.60 | 2.81 |

[a] No eggs laid.

[b] Missing values due to human-induced abandonment.

[c] Water covered bottom of cistern.

[d] Snake predation, 5 of 6 nestling consumed.

Table 3. Rodent biomass (g) live trapped in southwestern Oklahoma 1980, 1981 by repetition, and cover type, and mean biomass by cover type.

| | | COVER TYPE | | | | | |
|---|---|---|---|---|---|---|---|
| YEAR | REPETITION | WHEAT | MESQUITE | SORGHUM | HERBLAND | SPARSE ROADSIDE[a] | DENSE ROADSIDE[a] |
| 1980 | 1 | 0 | 42 | 746 | 81 | | |
| | 2 | 0 | 128 | 620 | 306 | | |
| | 3 | 22 | 200 | 752 | 519 | | |
| | 4 | 40 | 263 | 0 | 0 | | |
| 1981 | 1 | 23 | 73 | 89 | 0 | 0 | 526 |
| | 2 | 0 | 30 | 978 | 20 | 0 | 388 |
| | 3 | 0 | 74 | 547 | 406 | 0 | 332 |
| | 4 | 61 | 284 | 449 | 145 | 57 | 573 |
| $\bar{x}$ per repetition | | 18.3 | 136.8 | 522.6 | 184.6 | 14.3 | 454.8 |

[a] Not sampled in 1980.

Table 4. Percent of live biomass by species and nest site estimated from pellets and pellet fragments collected from 9 barn owl nest sites in southwestern Oklahoma (1980-1981).

| SPECIES | NEST SITE 1 (139)[a] | 2 (110) | 3 (31) | 4 (38) | 5 (141) | 6 (112) | 7 (7) | 8 (83) | 9 (39) | ALL SITES |
|---|---|---|---|---|---|---|---|---|---|---|
| Pocket mouse | 40 | 26 | 25 | 22 | 36 | 18 | 33 | 32 | 29 | 29.2 |
| Hispid cotton rat | 31 | 13 | 28 | 37 | 22 | 27 | 67 | 28 | 6 | 24.5 |
| Southern plains woodrat | 0 | 10 | 38 | 26 | 19 | 41 | 0 | 8 | 32 | 20.0 |
| Plains pocket gopher | 5 | 31 | 0 | 0 | 13 | 0 | 0 | 0 | 14 | 9.5 |
| Harvest mouse | 11 | 7 | 5 | 2 | 2 | 6 | 0 | 4 | 12 | 6.0 |
| Deer mouse | 8 | 4 | 2 | 8 | 2 | 5 | 0 | 20 | 5 | 5.4 |
| Northern grasshopper mouse | 5 | 9 | 2 | 5 | 6 | 3 | 0 | 8 | 2 | 5.4 |
| Least shrew | tr | tr | 0 | tr | tr | tr | 0 | tr | tr | tr |
| Desert shrew | tr | 0 | tr | 0 | 0 | tr | 0 | tr | 0 | tr |
| Total | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100.0 |

[a] Number of skulls per nest site.

tr = < 1%

Table 5. Frequency of occurrence (%) of prey species in pellets collected from 9 nest sites in southwestern Oklahoma (1980-1981).

| | NEST SITE | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | ALL |
| SPECIES | (56)[a] | (32) | (12) | (18) | (33) | (24) | (3) | (33) | (14) | SITES |
| Pocket mouse | 41.0 | 43.8 | 50.0 | 44.4 | 57.6 | 28.0 | 100.0 | 45.5 | 64.2 | 46.0 |
| Hispid cotton rat | 12.5 | 12.5 | 25.0 | 27.8 | 3.0 | 36.0 | 33.0 | 12.1 | 0.0 | 15.0 |
| Southern plains woodrat | 0.0 | 6.3 | 8.3 | 16.7 | 3.0 | 16.0 | 0.0 | 3.0 | 21.4 | 6.6 |
| Plains pocket gopher | 1.7 | 3.1 | 0.0 | 0.0 | 9.1 | 0.0 | 0.0 | 0.0 | 7.1 | 2.7 |
| Harvest mouse | 35.7 | 34.4 | 25.0 | 16.7 | 15.2 | 44.0 | 0.0 | 18.2 | 28.5 | 27.9 |
| Deer mouse | 23.2 | 28.1 | 8.3 | 44.4 | 12.1 | 24.0 | 0.0 | 54.5 | 14.3 | 27.0 |
| Northern grasshopper mouse | 8.9 | 25.0 | 8.3 | 16.7 | 21.2 | 12.0 | 0.0 | 18.2 | 0.0 | 14.7 |
| Least shrew | 7.1 | 3.1 | 0.0 | 11.1 | 6.1 | 4.0 | 0.0 | 6.1 | 14.3 | 6.2 |
| Desert shrew | 3.6 | 0.0 | 0.0 | 0.0 | 0.0 | 4.0 | 0.0 | 3.0 | 0.0 | 1.8 |

[a] Number of pellets in sample.

Table 6. Use and availability (%) of cover types within a 1-km radius of the nest site of 8 radio-equipped barn owls near Eldorado, Oklahoma (1980,1981)

| YEAR | NEST SITE | SEX | WHEAT | | MESQUITE | | HERBLAND | | SORGHUM | | % RADIO LOCATIONS IN CIRCLE |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | AVAIL. | USE | AVAIL. | USE | AVAIL. | USE | AVAIL. | USE | |
| 1980 | 1 | F | 60.5 | 90.0 | 14.8 | 0.0 | 23.5 | 10.0 | 1.2 | 0.0 | 22.2 |
| 1980 | 1 | M | 60.5 | 65.8 | 14.8 | 15.8 | 23.5 | 15.8 | 1.2 | 2.6 | 69.0 |
| 1980 | 6 | M | 14.5 | 19.0 | 78.8 | 80.9 | 0.0 | 0.0 | 6.7 | 0.0 | 50.0 |
| 1981 | 1 | F | 60.5 | 57.1 | 14.8 | 7.1 | 23.5 | 35.7 | 1.2 | 0.0 | 51.7 |
| 1981 | 2 | F | 51.2 | 80.0 | 38.6 | 0.0 | 4.2 | 20.0 | 6.1 | 0.0 | 81.3 |
| 1981 | 2 | M | 51.2 | 66.7 | 38.6 | 22.2 | 4.2 | 11.1 | 6.1 | 0.0 | 51.2 |
| 1981 | 3 | F | 55.0 | 14.3 | 23.6 | 42.9 | 19.9 | 42.9 | 1.4 | 0.0 | 28.6 |
| 1981 | 4 | F | 22.1 | 12.5 | 76.7 | 50.0 | 0.0 | 0.0 | 1.2 | 37.2 | 35.2 |

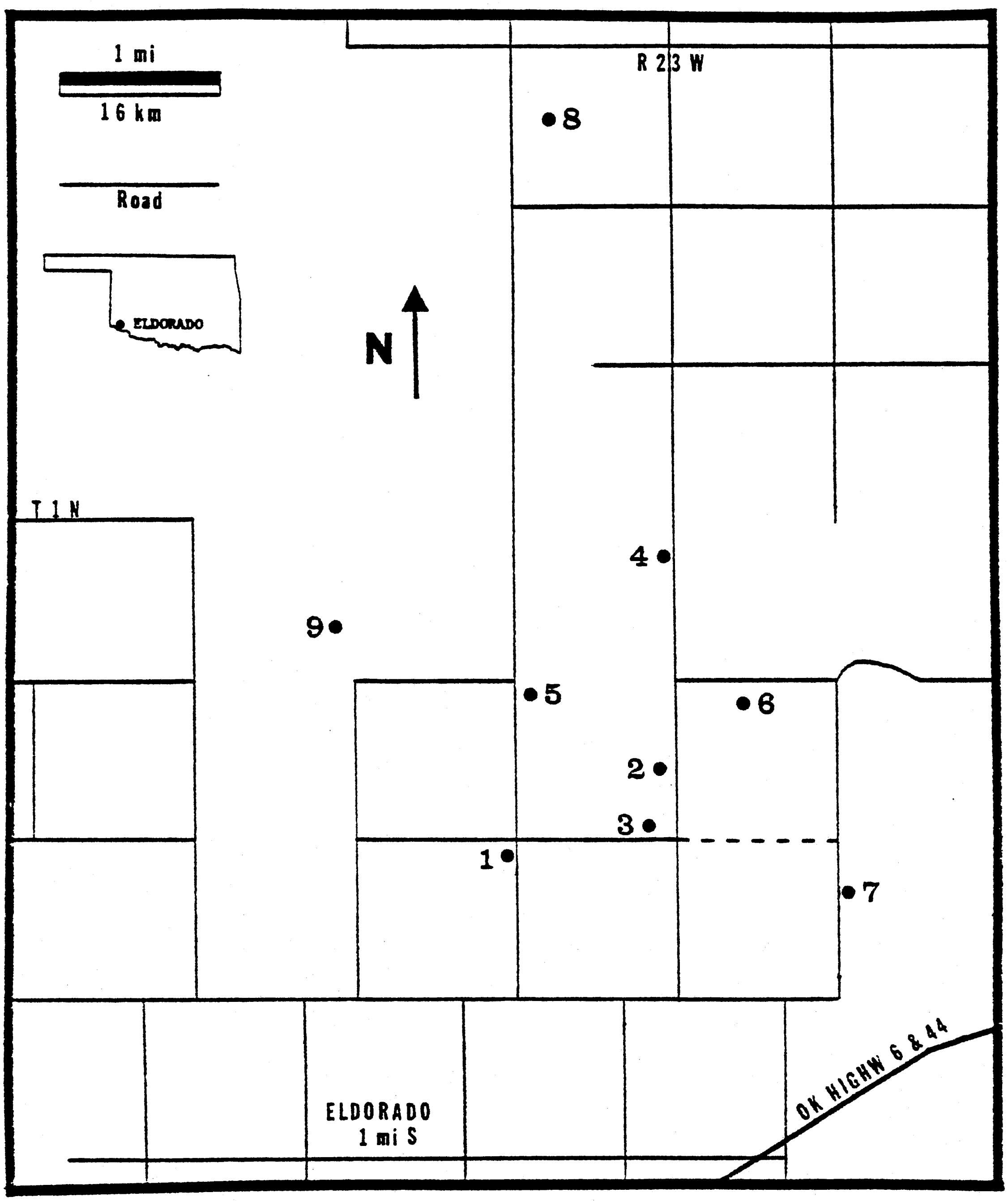
Table 7. Percent of locations, by cover type, for 8 radio-equipped barn owls, during 1980 and 1981, near Eldorado, Oklahoma.

| YEAR | NEST SITE | SEX | COVER TYPE WHEAT | MESQUITE | SORGHUM | HERBLAND | TOTAL NUMBER OF LOCATIONS |
|---|---|---|---|---|---|---|---|
| 1980 | 1 | F | 64.4 | 28.9 | 2.2 | 4.4 | 45 |
| 1980 | 1 | M | 60.0 | 18.2 | 5.5 | 16.4 | 55 |
| 1980 | 6 | M | 35.7 | 61.9 | 2.4 | 0.0 | 42 |
| 1981 | 1 | F | 55.6 | 18.5 | 0.0 | 25.9 | 58 |
| 1981 | 2 | F | 33.3 | 0.0 | 0.0 | 66.6 | 16 |
| 1981 | 2 | M | 83.3 | 11.1 | 0.0 | 5.5 | 39 |
| 1981 | 3 | F | 45.8 | 16.7 | 8.3 | 29.2 | 56 |
| 1981 | 4 | F | 43.5 | 43.5 | 13.0 | 0.0 | 54 |

Table 8. Nest site and year of capture (A) and recapture (B) of 20 nesting adult barn owls banded from 1977-1981 near Eldorado, Oklahoma.

| | | YEAR | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1977 | | 1978 | | 1979 | | 1980 | | 1981 | |
| BIRD NO. | SEX | A | B | A | B | A | B | A | B | A | B |
| 1 | F | 2 | | | 2 | | | | | | |
| 2 | F | 5 | | | | | | | | | |
| 3 | F | 9 | | | | | | | | | |
| 4 | M | 9 | | | | | | | | | |
| 5 | F | | | 1 | | | 3 | | | | 3 |
| 6 | F | | | 8 | | | | | | | |
| 7 | F | | | | | 6 | | | 6 | | 4 |
| 8 | F | | | | | 4 | | | | | |
| 9 | M | | | | | 4 | | | | | |
| 10 | F | | | | | 2 | | | 2 | | 2 |
| 11 | M | | | | | | | 1 | | | |
| 12 | F | | | | | | | 1 | | | 5 |
| 13 | M | | | | | | | 6 | | | |
| 14 | F | | | | | | | 4 | | | |
| 15 | M | | | | | | | 8 | | | |
| 16 | M | | | | | | | 1 | | | |
| 17 | M | | | | | | | | | 2 | |
| 18 | F | | | | | | | | | 1 | |
| 19 | M | | | | | | | | | 8 | |
| 20 | F | | | | | | | | | 8 | |

LIST OF FIGURES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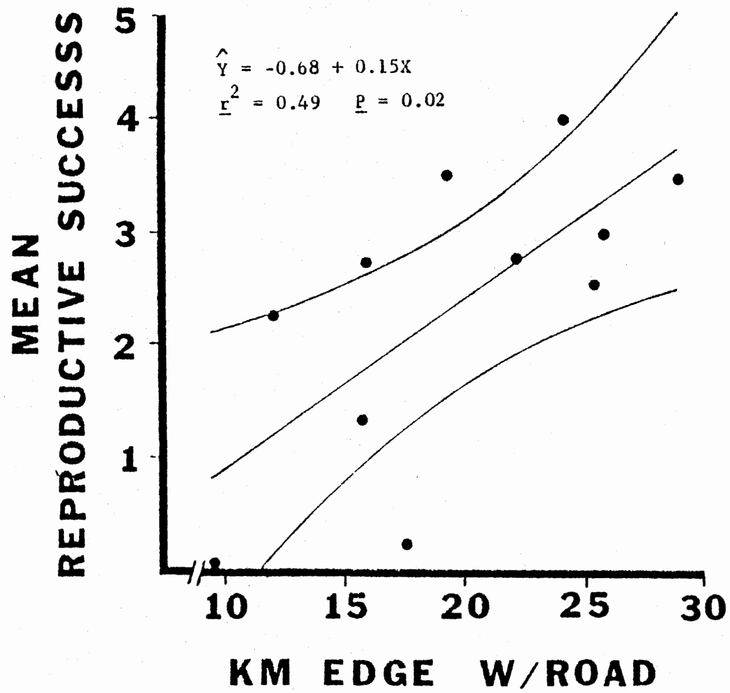
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$\underline{r}^2 = 0.49 \quad \underline{P} = 0.02$
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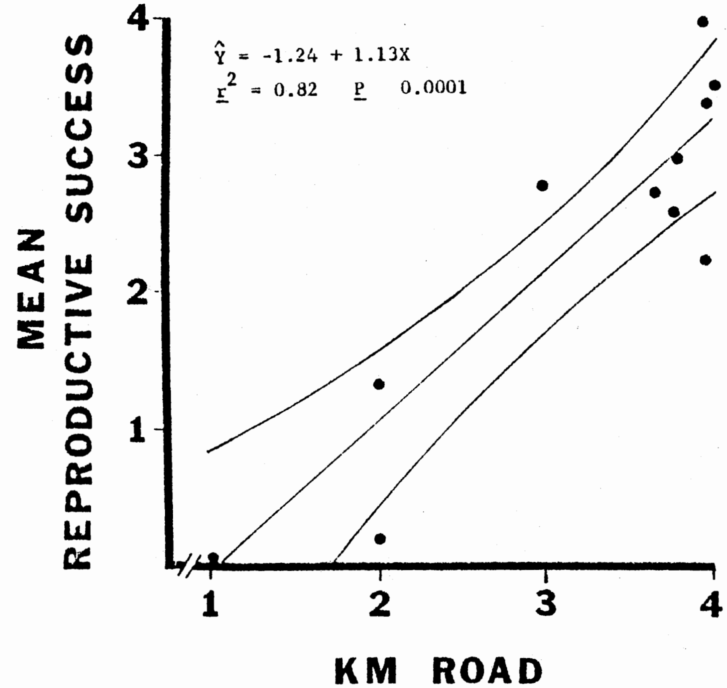
3
2
1
10
15
20
25
30
KM EDGE W/ROAD

A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$\underline{r}^2 = 0.82 \quad \underline{P} \quad 0.0001$
MEAN REPRODUCTIVE SUCCESS
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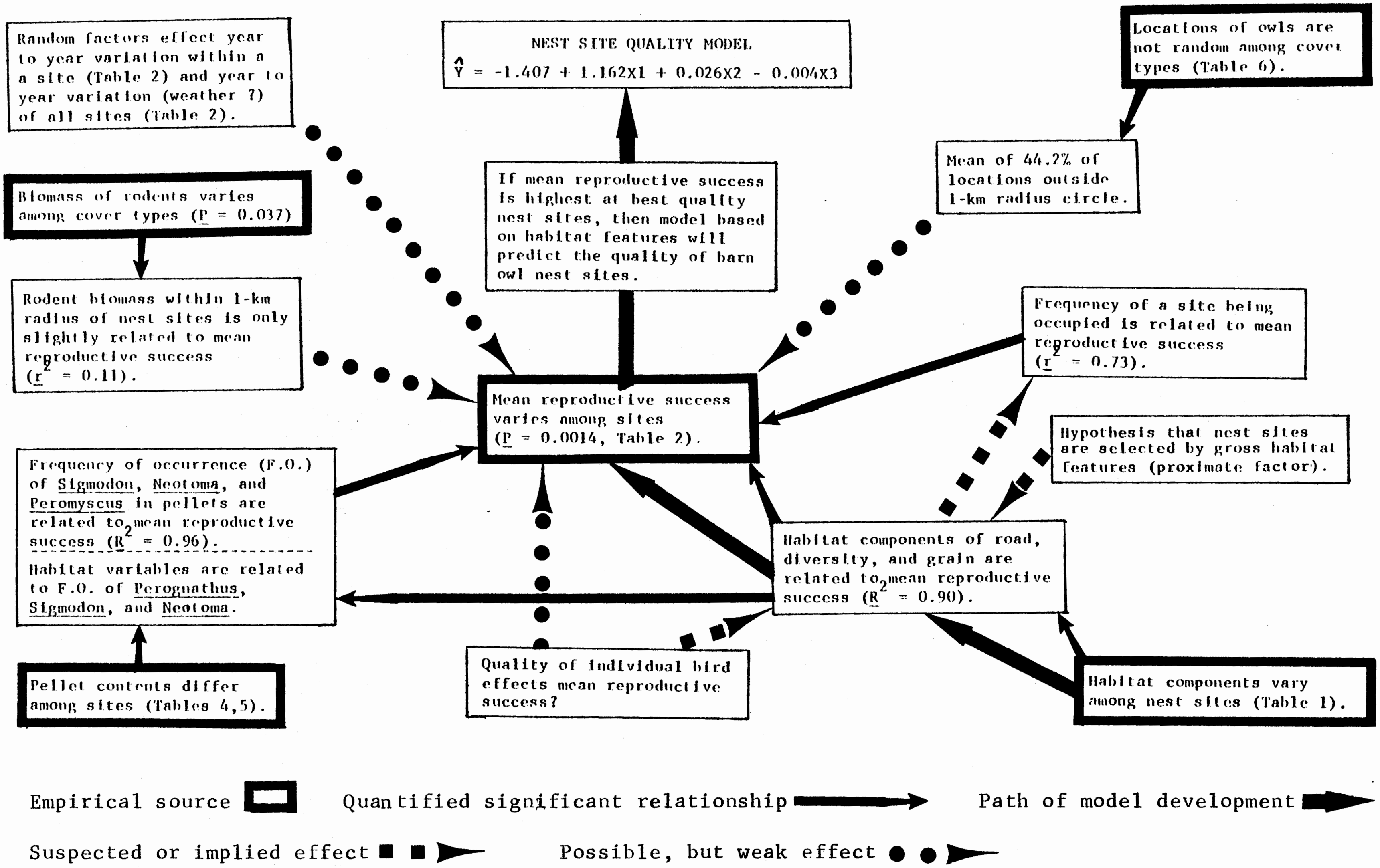
3
2
1
1
2
3
4
KM ROAD

B


NEST SITE QUALITY MODEL
Ŷ = -1.407 + 1.162X1 + 0.026X2 - 0.004X3
Random factors effect year to year variation within a a site (Table 2) and year to year variation (weather ?) of all sites (Table 2).
Biomass of rodents varies among cover types (P = 0.037)
Rodent biomass within 1-km radius of nest sites is only slightly related to mean reproductive success (r2 = 0.11).
If mean reproductive success is highest at best quality nest sites, then model based on habitat features will predict the quality of barn owl nest sites.
Locations of owls are not random among cover types (Table 6).
Mean of 44.2% of locations outside 1-km radius circle.
Frequency of a site being occupied is related to mean reproductive success (r2 = 0.73).
Mean reproductive success varies among sites (P = 0.0014, Table 2).
Hypothesis that nest sites are selected by gross habitat features (proximate factor).
Frequency of occurrence (F.O.) of Sigmodon, Neotoma, and Peromyscus in pellets are related to mean reproductive success (R2 = 0.96).
Habitat variables are related to F.O. of Perognathus, Sigmodon, and Neotoma.
Habitat components of road, diversity, and grain are related to mean reproductive success (R2 = 0.90).
Pellet contents differ among sites (Tables 4,5).
Quality of individual bird effects mean reproductive success?
Habitat components vary among nest sites (Table 1).
Empirical source
Quantified significant relationship
Path of model development
Suspected or implied effect
Possible, but weak effect

VITA

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